Solving for the transformation parameters t, an over-constrained system of linear equations is constructed.

$$\begin{bmatrix} & & & & & & & \\ X_i & Y_i & 1 & X_i & Y_i & 1 & -X_i u_i' & -Y_i u_i' \\ -X_i & -Y_i & -1 & X_i & Y_i & 1 & -X_i v_i' & -Y_i v_i \\ & & & & & & & \end{bmatrix} \begin{bmatrix} t_{11} \\ t_{12} \\ t_{13} \\ t_{21} \\ t_{22} \\ t_{23} \\ t_{31} \\ t_{32} \end{bmatrix} = \begin{bmatrix} \\ \\ u_i + v_i \\ -u_i + v_i \\ \\ \end{bmatrix}$$

Each pair of rows in the matrix covers the i^{th} projection mark. The transformation parameters may now be solved for, using singular value decomposition.

Returning to FIG. **7**, in step **178** the new cumulative error in the landmark projections, determined as the difference between the current squared error and the squared error from the last iteration, are tested to fall within a previously determined threshold.

Finally, returning to FIG. **3**, step **108** performs perspective corrections on all the tiles using the perspective transformation determined in step **106**. Having made the corrections to the image tiles and locating the transformed tiles in whiteboard coordinates, the whiteboard may then be processed to create an electronic representation of the image on the whiteboard. The corrections for each tile may be combined to provide an electronic registration pattern for the tiles, so that scanning systems, such as described in previously incorporated U.S. Pat. application Ser. No. 08/303,918, may combine the image tiles correctly for further processing.

The source of the projected alignment pattern could be as simple as a conventional slide projector where the projected pattern is given by an image on a slide. This light source could be a regular visible light, or it could be a light in the infrared range. A low-power laser which is split into a grid using an optical beam splitter could provide points of IR or visible light, or alternatively the laser light pattern could be dynamically produced via optics and electronics as in the case of laser printers, where a single or multliple laser beam is scanned rapidly in a 2D pattern.

In order to minimize the distortion of the alignment pattern due to surface slope in directions non-parallel to the image plane, the optical axis of the alignment pattern projector should be as close as possible to the optical axis of the camera. For example, FIG. **10** shows a system **220** with a surface **228** to be imaged. Projector **222** and camera **224** share the same optical axis and optical center using a half-silvered mirror **226**.

C. Miscellaneous

This technique described herein is useful in situations when marks on the whiteboard are not adequate to effectively provide registration details —either the marks are too sparse or too dense, or are ambiguous or difficult to resolve. By projecting artificial marks that are visible to the system, but not distracting to the human users, the system may more easily match the image tiles to one another.

Although the invention has been described in relation to various implementations, together with modifications, variations and extensions thereof, other implementations, modifications, variations and extensions are within the scope of the invention. The invention is therefore not limited by the description contained herein or by the drawings, but only by the claims.

What is claimed:

1. A method for providing a complete undistorted computational representation of an image on a surface, the method comprising the steps of:

a) projecting a light pattern upon the image, the light pattern including a multiplicity of lightmarks, each lightmark having a neighborhood;

b) capturing a multiplicity of image tiles using at least one camera subsystem, each of the image tiles including a portion of the image and at least a one of the lightmarks, each image tile having an overlapping area for each adjacent image tile overlapped by the image tile;

c) converting the image tiles into a computational format;

d) for each image tile, identifying the overlapping areas;

e) correcting distortions of the image tiles, including perspective distortion, to produce a single undisturbed, computational representation of the image by the substeps of:

1) identifying the lightmarks within the overlapping areas;

2) performing local correlations of image patches in the neighborhoods of the lightmarks within the overlapping areas to identify locations in each image tile of the lightmarks within the overlapping areas;

3) projecting the lightmark locations into surface coordinates;

4) for each pair of overlapping, adjacent image tiles, comparing corresponding pairs of lightmarks within the overlapping area common to the pair of overlapping, adjacent image tiles;

5) for each pair of lightmarks within the overlapping area common to a pair of overlapping, adjacent image tiles, choosing target coordinates at a location intermediate to the surface coordinates of each of the pair of lightmarks within the overlapping area common to the pair of overlapping, adjacent image tiles;

6) computing perspective transforms for each image tile using the target coordinates for the lightmarks within the overlapping areas;

7) repeating substeps 1)–6) until convergence upon locations of lightmarks within the overlapping area of each image tile that represent a cumulative error in surface coordinates of the lightmarks within the overlapping areas of each image tile that is less than a threshold amount.

2. The method of claim **1** wherein step e**3**) comprises the steps of: for each pair of overlapping, adjacent image tiles:

A) finding a first location of a first liqhtmark of the lightmarks within the overlapping area common to the pair of overlapping, adjacent image tiles, the first location being within a surface co-ordinate system and being found given a location of the first lightmark within a first co-ordinate system associated with a first tile of the pair of overlapping, adjacent image tiles;

B) finding a second location of the first lightmark within the surface co-ordinate system given a location of the first lightmark within a second co-ordinate system